

Evaluation of the Shuttle Radar Topography Mission Data Level 2 (SRTM 2) at Yuma Proving Grounds



Implications on Line of Sight (LOS)

Briefing to LOS TWG

DEC 2004

SRTM Background

- **SRTM was the primary mission on the STS-99 11-day mission of Space Shuttle Endeavor (11 February 2000). This mission collected systematic interferometric data for 99.96% of the world's landmass once and 94.59% of the landmass two or more times. The targeted landmass area was between 56 degrees south and 60 degrees north latitude.**
- **SRTM data was processed into 1- and 3-arc seconds (about 30m and 100m; SRTM2 and SRTM1) resolution and stored in files representing one-degree cells. Approximately 15,000 cells will be available.**
- **SRTM now comprises the bulk of the National Geospatial Intelligence Agency's (NGA) elevation data holdings and is quickly becoming a critical "backbone" mapping tool for the future.**

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Background

TRAC-WSMR and TEC have been working together since 1993 to develop and refine methodologies to help verify the accuracy of DEMs. Two methodologies have been used to verify accuracy. First, precise surveying techniques were modified to collect line-of-sight (LOS) in the field and comparing this LOS to computer calculated LOS. In addition, in areas of interest, terrain profiles were collected and compared to computer generated profiles. DEM accuracy has been determined for the following locations:

Fort Irwin, CA (two sites) (1994) Yuma, AZ (1996, 2004)

**Twentynine Palms, CA (1994) Fort Benning, GA (1996)
Yakima, WA (1994) Fort Bliss, TX (2003)**

Current Work

- **This briefing will examine two DEMs.**
 - **Standard DTED Level 2**
 - **SRTM Level 2**
- **This evaluation will focus on a 10 by 10 kilometer area.**
- **Yuma Proving Grounds was selected for the evaluation**
 - **absence of vegetation**
 - **previous extensive LOS field data collection at site**

Methodology

- **Several sites were selected to provide representative coverage of the DEM.**
- **Multiple azimuths from each site were walked and the locations where LOS changed were noted. LOS from the field was compared to computer-calculated LOS (DYNTACS LOS Algorithm).**
- **Terrain profiles across the terrain were collected and compared to computer generated profiles.**

Yuma - Sample Terrain *(1 of 3)*



Yuma - Sample Terrain (2 of 3)

**Maximum Elevation Difference is 250m
over 100 sq kilometers**



Yuma - Sample Terrain *(3 of 3)*



Visual Evaluation *(1 of 3)*

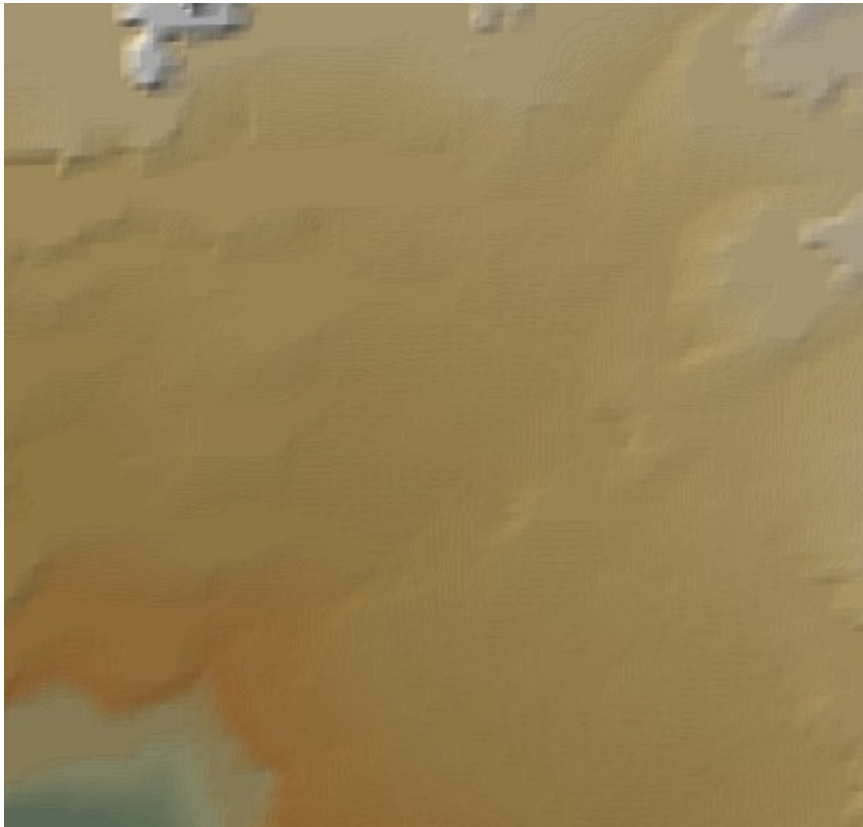


- **25m resolution DEM from a very accurate source**
- **Note the details of the arroyos and the hills**

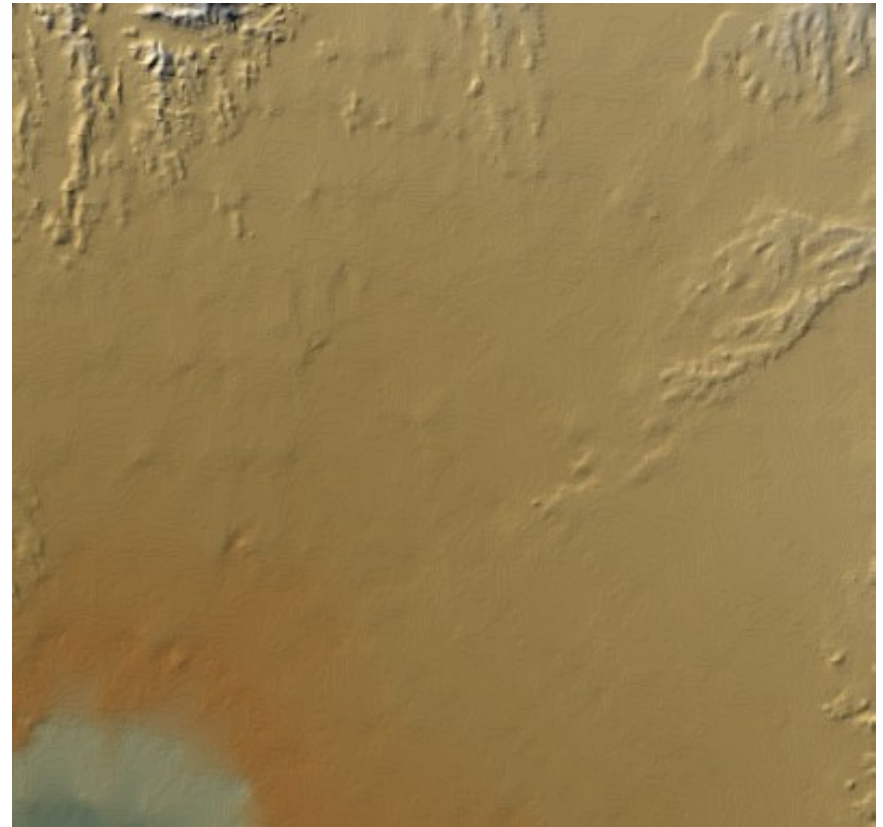
Visual Evaluation *(2 of 3)*

- **Standard NGA Products**
 - **Many of the terrain features have disappeared**

DTED Level 1



DTED Level 2

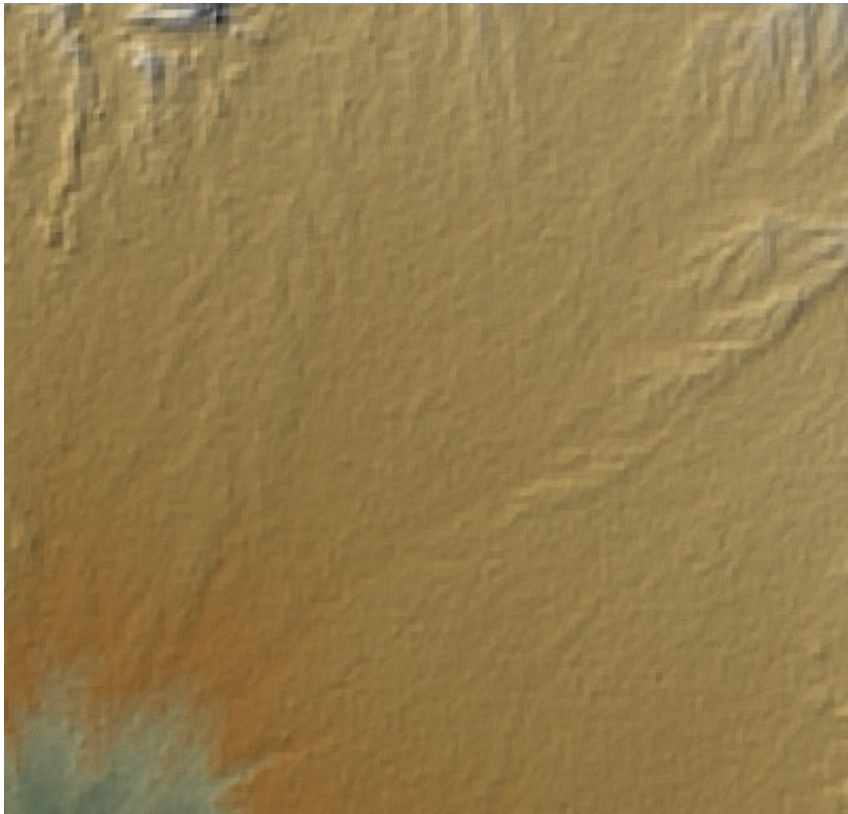


Visual Evaluation *(3 of 3)*

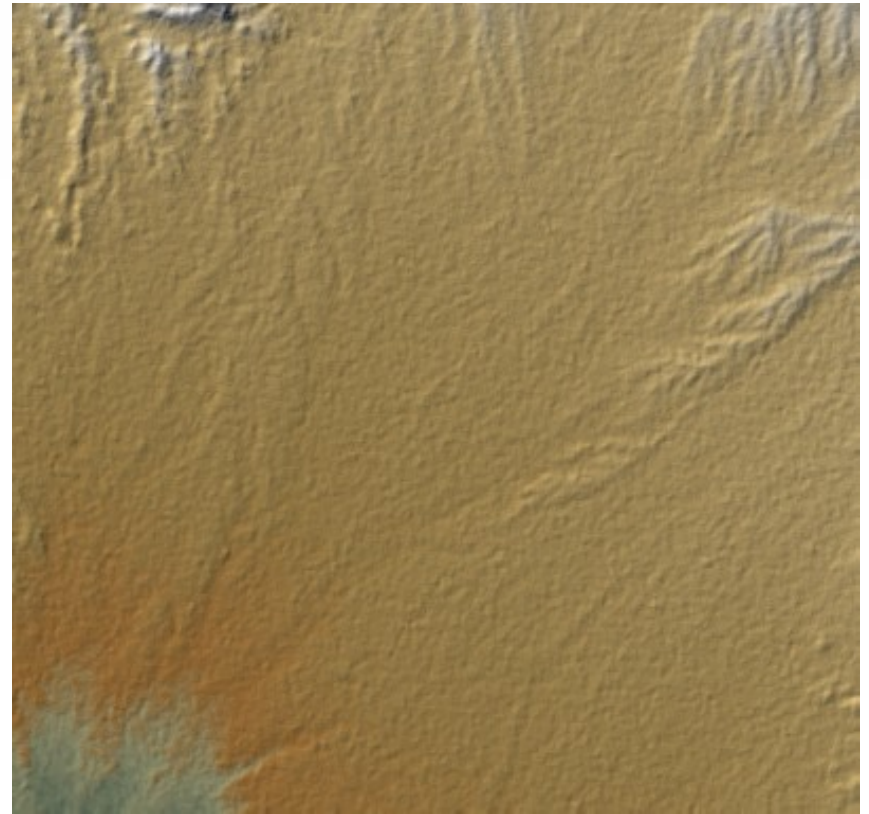
- **SRTM Data Sources**

- The terrain features are better defined, but there is random noise.

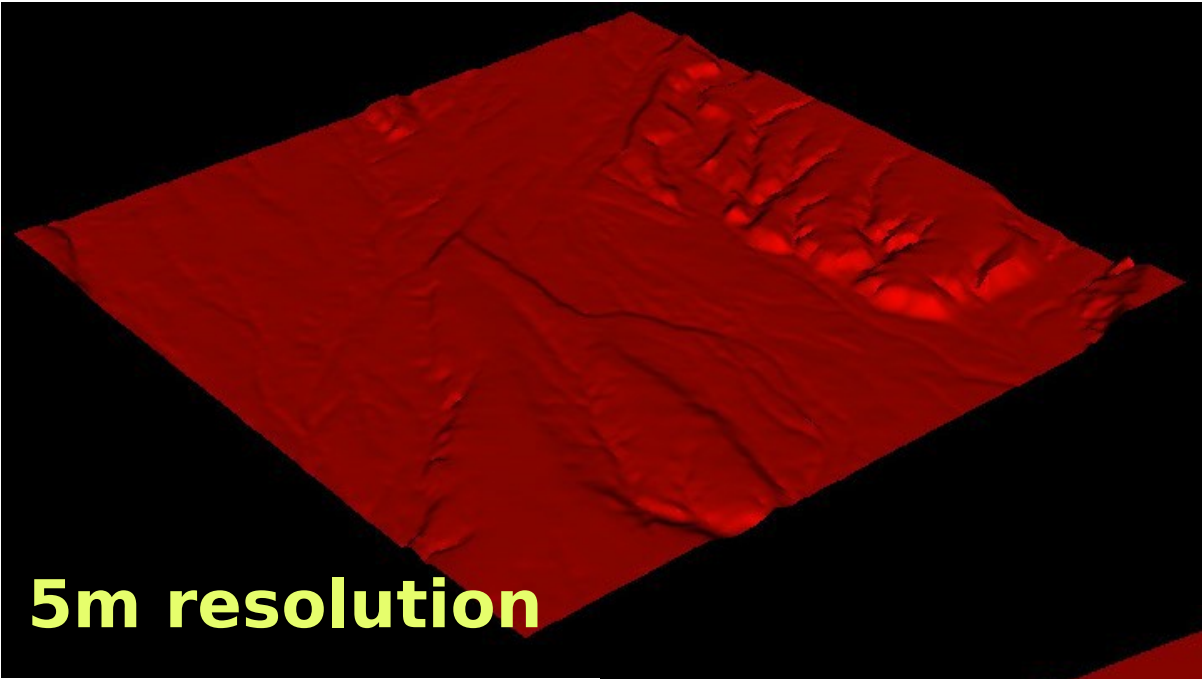
SRTM Level 1



SRTM Level 2

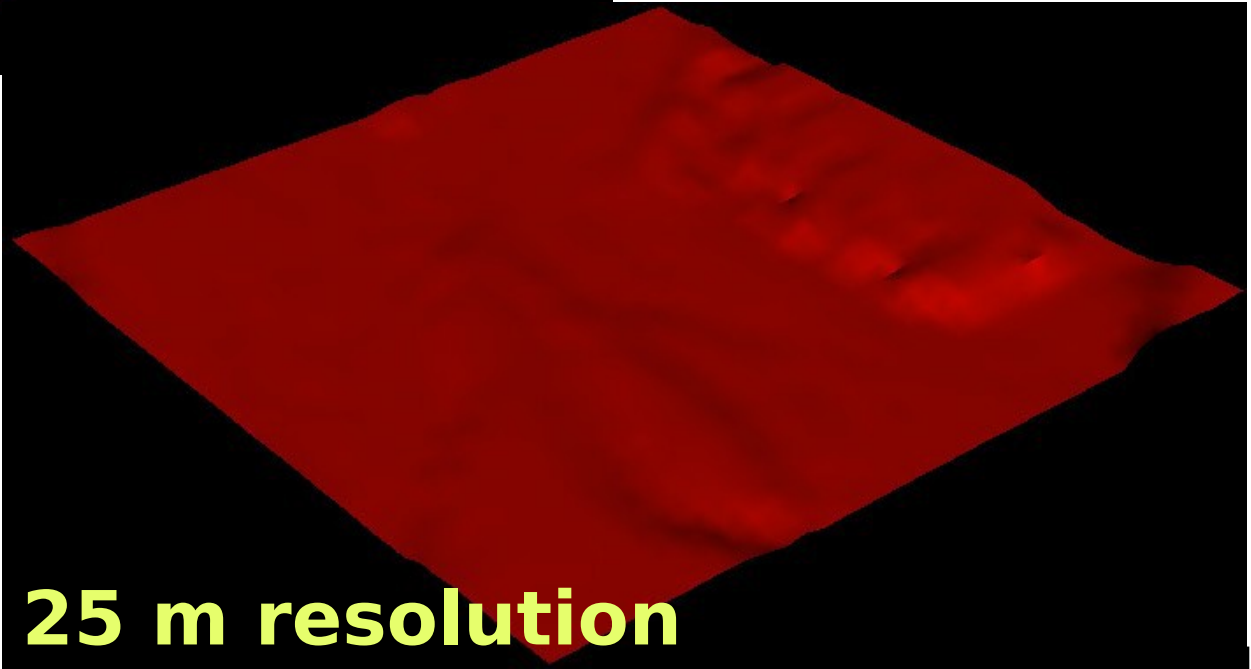


Perspective View *(1 of 2)*



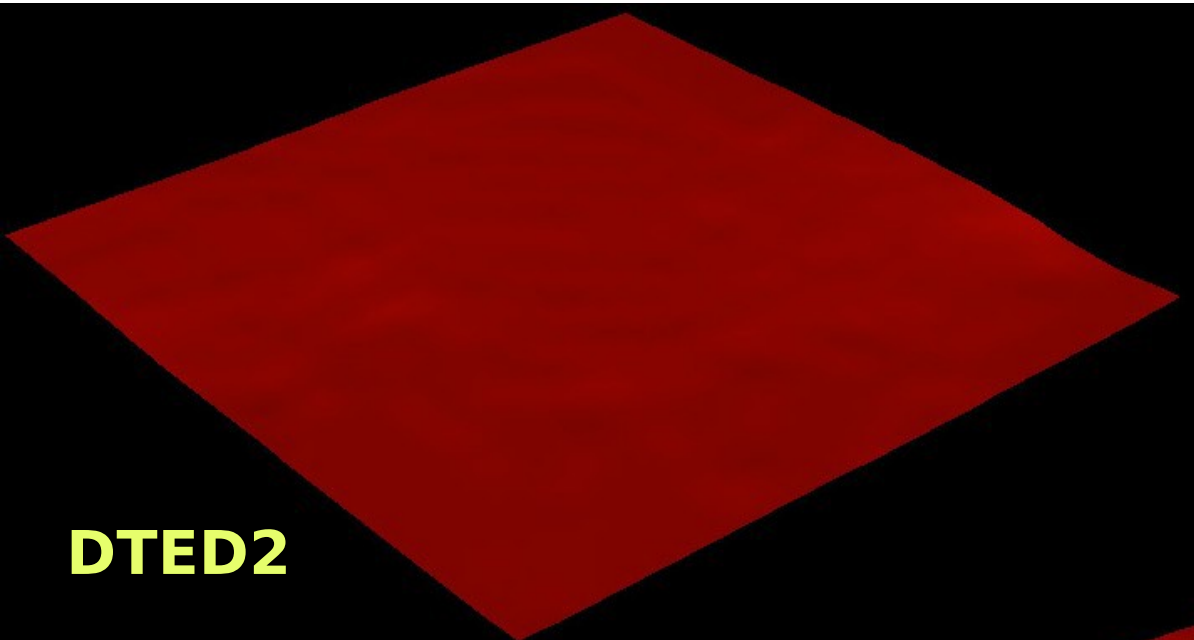
5m resolution

**Original 5m DEM
source data**



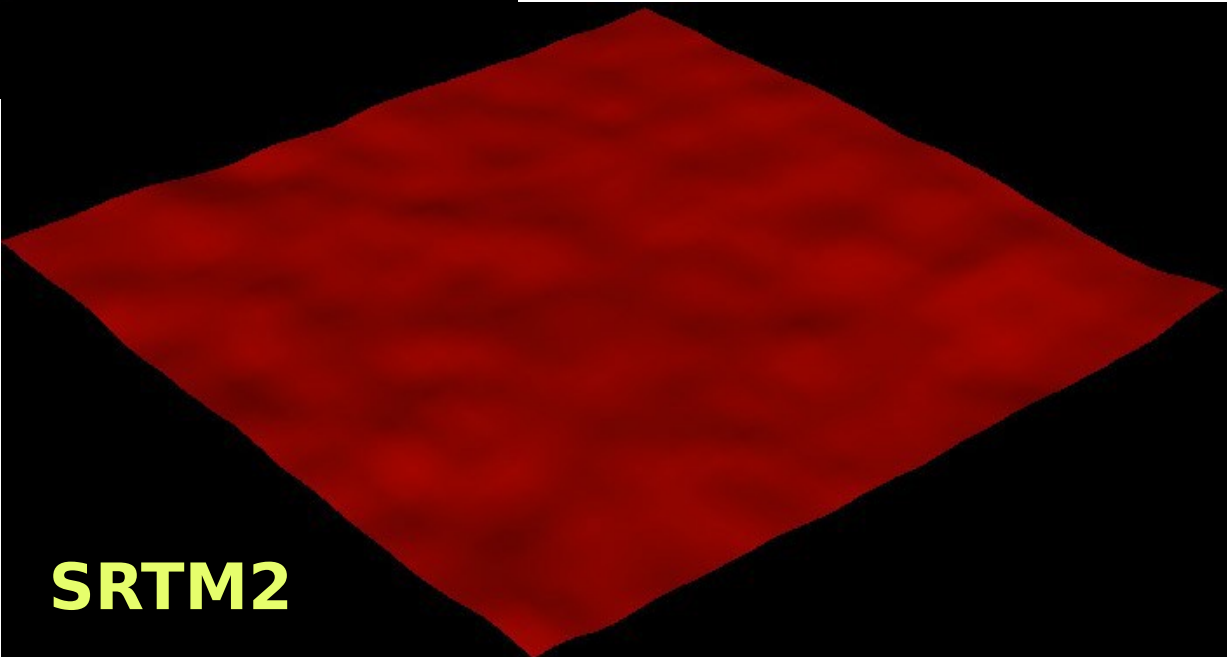
25 m resolution

Perspective View *(2 of 2)*



DTED2

A perspective view of a red, textured surface, likely a map or terrain, displayed on a black background. The surface is tilted, showing a grid-like pattern of lines. The label "DTED2" is positioned in the bottom-left corner of the image area.



SRTM2

A perspective view of a red, textured surface, likely a map or terrain, displayed on a black background. The surface is tilted, showing a grid-like pattern of lines. The label "SRTM2" is positioned in the bottom-left corner of the image area.

September

LOS Evaluation

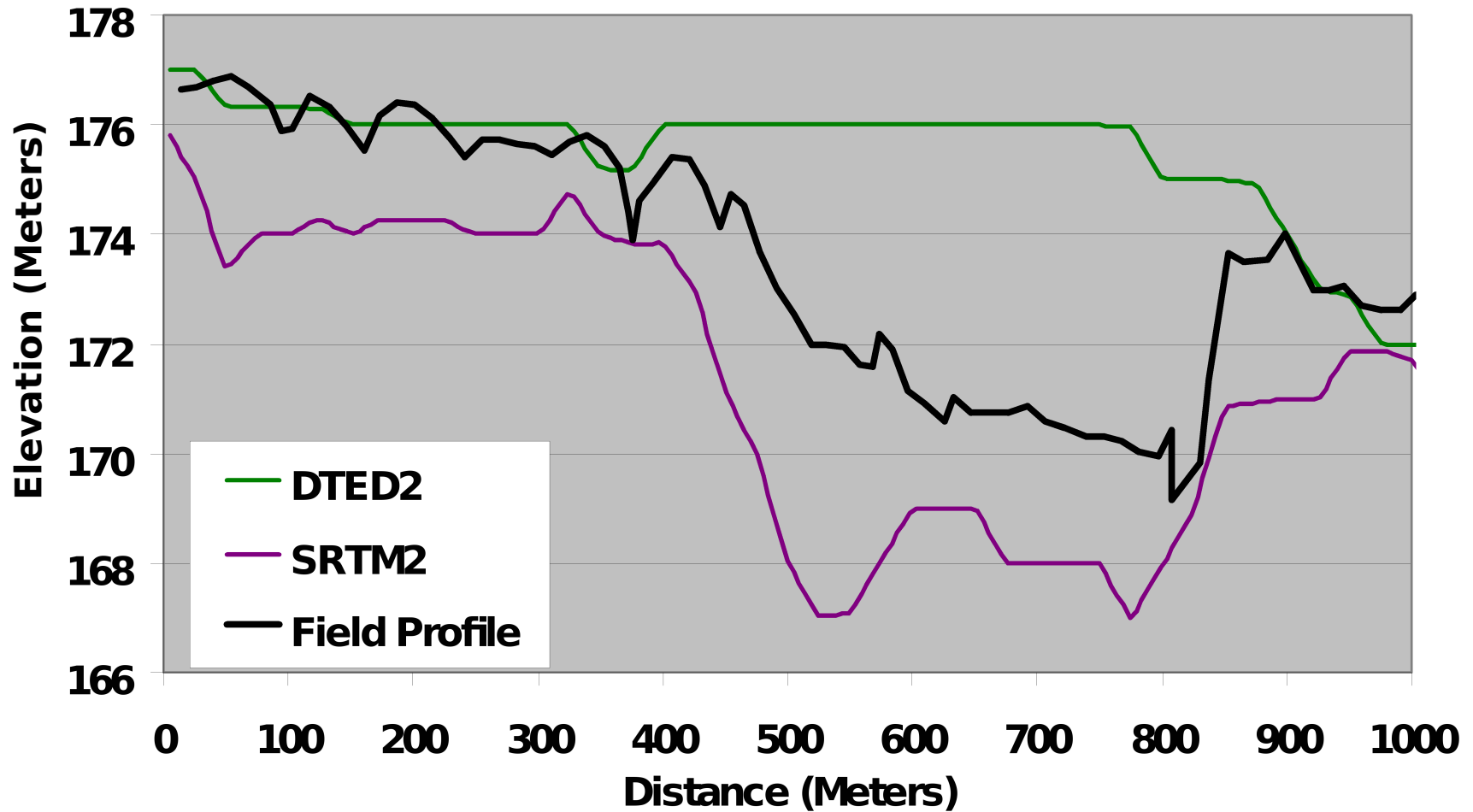
- **Agreement Between Computer Generated LOS and Field Collected LOS**

<u>Data Source</u>	<u>Agreement with Field</u>	
<u>PLOS</u>		
DTED2	69.1	0.61
SRTM2	71.5	0.38



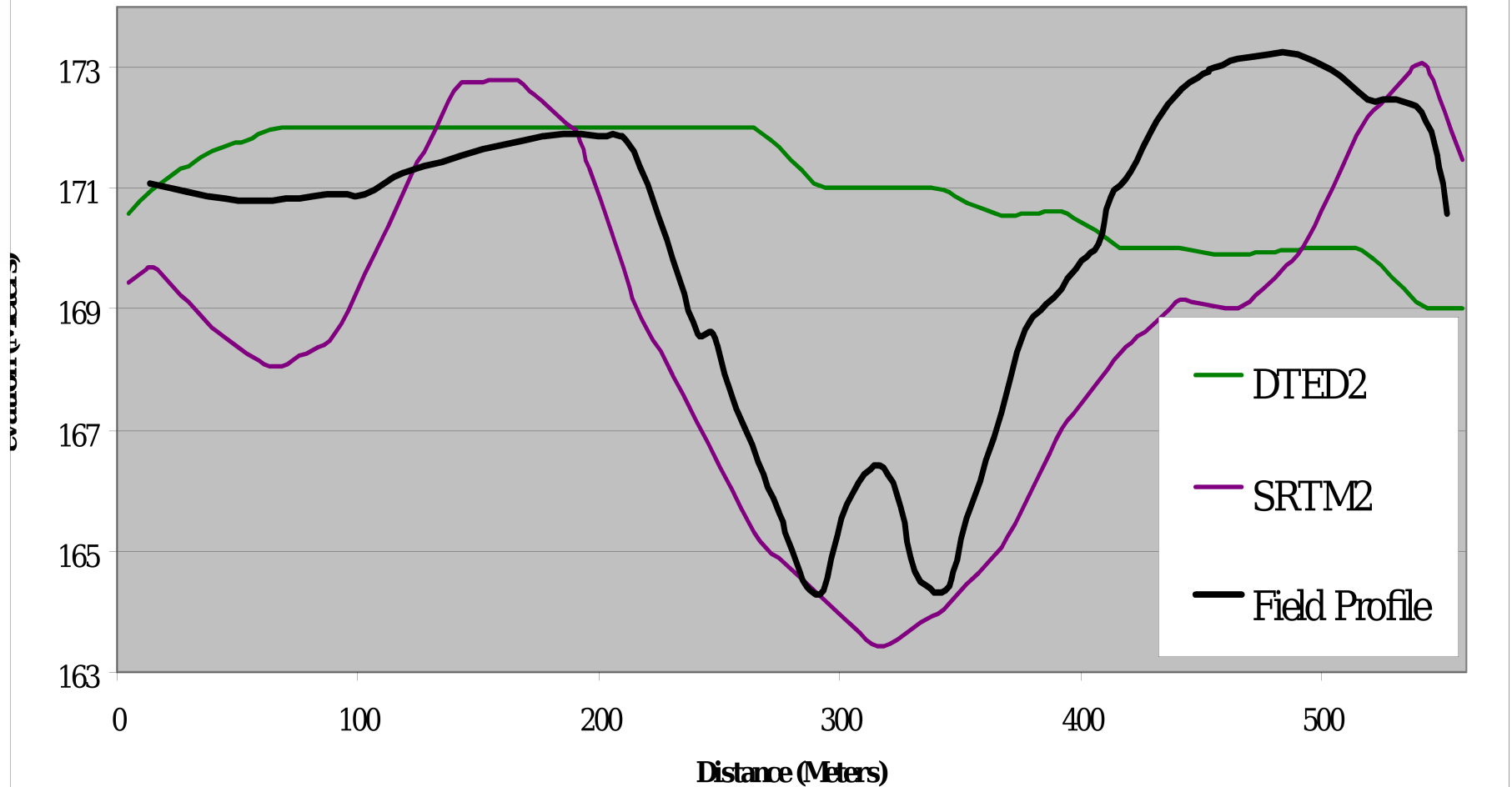
Line of Sight Profiles

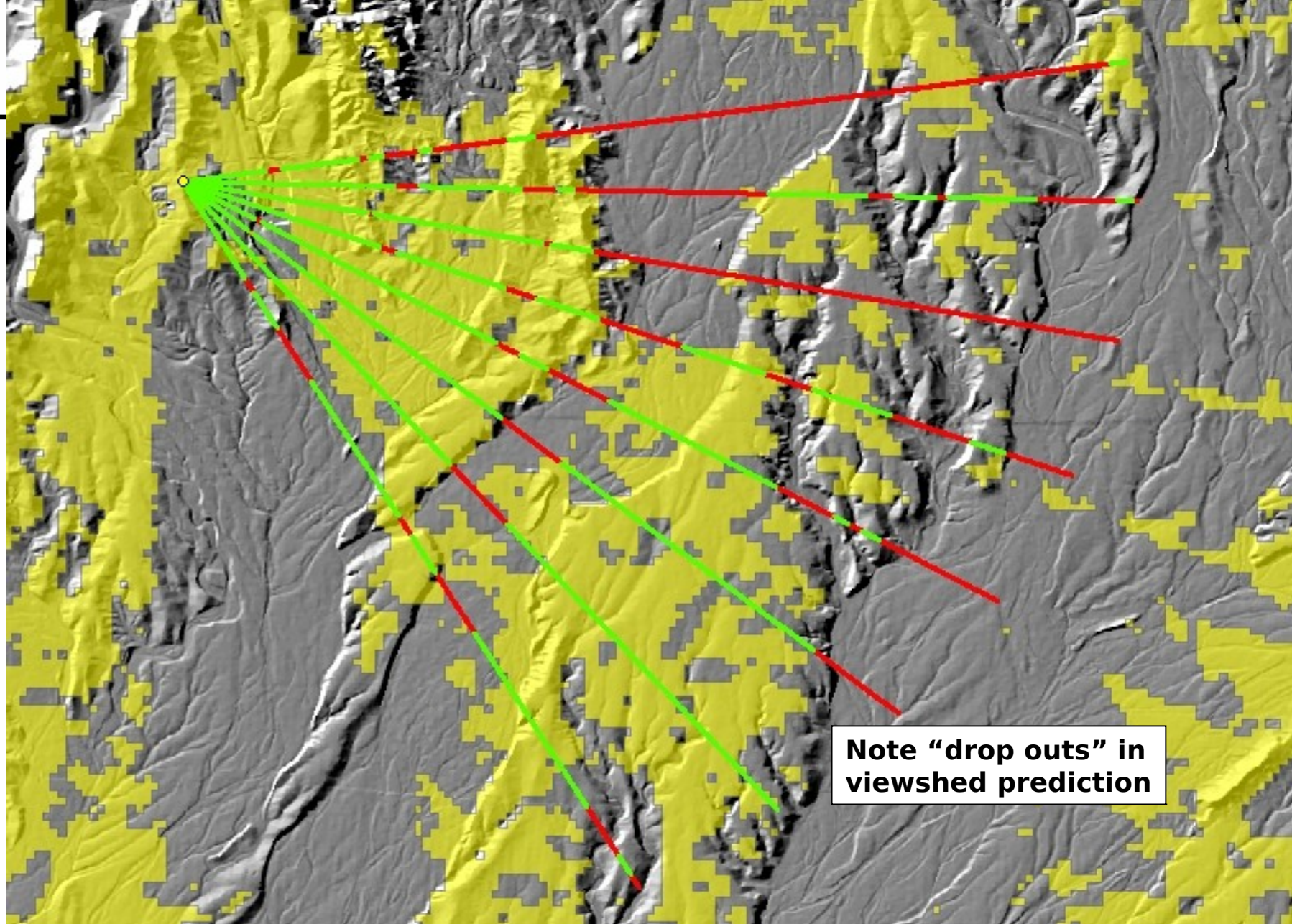
Site 4 - Profile 2



Line of Sight Profiles

Site 6 - Profile 2



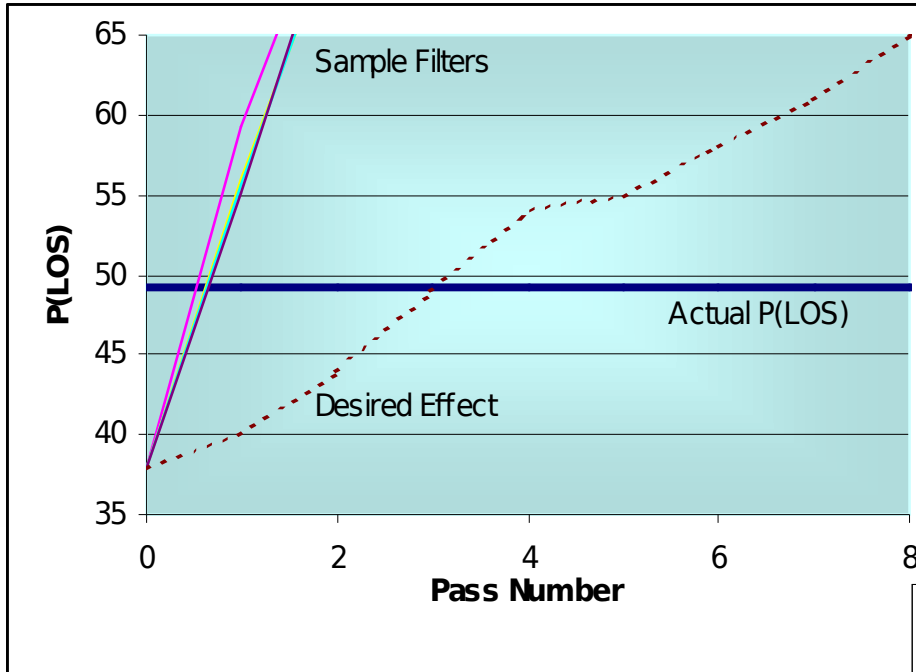


Note "drop outs" in
viewshed prediction

Yuma Area 6 Line-of-Sight Field Data - SRT2 Viewshed (3.6 KM x 4.4 KM)

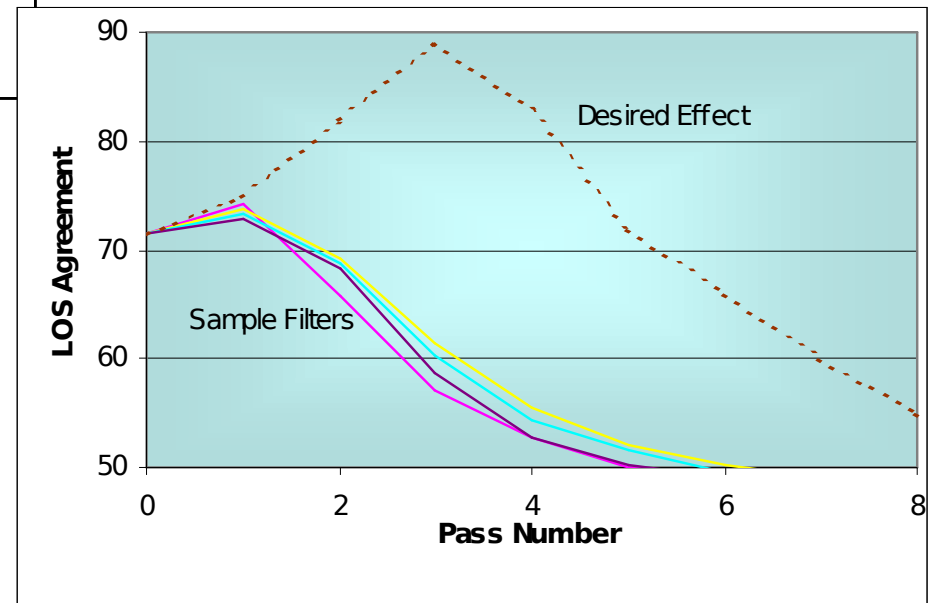
Source: 5m Photogrammetric DEM Shaded Relief; Yellow Represents SRT2

Low Pass Filter Theory



As the number of passes increase, the terrain becomes smoother and PLOS increases

As the number of passes increase, LOS agreement should increase for a while and then decrease as terrain becomes too smooth



Summary

- **SRTM2 data contains details about the terrain not available in DTED Level 2.**
- **SRTM2 data also contains random data noise that remains after processing (radar characteristic).**
- **The noise-induced anomalies create erroneous results in LOS and related visualization applications especially at the low grazing angles required for most Army operations.**
- **Inherent characteristics of SRTM2 and DTED Level 2 mitigates utility for LOS**
 - **SRTM2 underestimates LOS due to unfiltered random data noise**
 - **DTED Level 2 overestimates LOS due to excessive smoothing in production process**

Follow-on Work

- **Different low-pass filters will be tested on SRTM2 data to attempt to eliminate the noise while maintaining detail.**
- **Additionally, analysis will also be conducted on void areas (places where SRTM2 was not able to obtain elevations) and the effects of vegetation on SRTM signal.**
- **A future project will examine the effects of vegetation on the quality of the SRTM2 data.**